[Proceeding] Interaction design for cultural heritage. A robotics cultural game to visit the museum's inaccessible areas

DESIGN FOR NEXT
EAD12-ROME

Design for Next

12th EAD Conference
Sapienza University of Rome
12-14 April 2017

Interaction design for cultural heritage.

A robotic cultural game for visiting the museum's inaccessible areas.

Germak Claudio[a], Giuliano Luca[a]*, Lupetti Maria Luce[a]

[a] Politecnico di Torino
*Corresponding author e-mail: luca.giuliano@polito.it

Abstract: Nowadays many museum areas are not accessible to visitors because of issues related to security or architectural barriers. Make explorable these areas is one of the sensible topics in the cultural debate about the enhancing of the visiting experience. The paper describes the design of a roboethics activity conceived in codesign with museum stakeholders (Museum Guides, Museum Curators, Telecommunication Experts, Designers and Final Users) with the purpose to face this problem. After a first stage, in which a telepresence robot piloted by the Museum Guide it has been used a to show the inaccessible areas of the museum; it is going to be performed a second stage of the project with the scope of building a more interactive visiting experience. To satisfy this need an interactive game, it has been developed. The game is based both on the robot ability to be driven by the visitors and also on the capacity of the robot to been used as a platform for the digital storytelling.
The whole experience it has been designed and tested with the support of high school students.

Keywords: Museum exhibit, gamification, human robot interaction, exploring inaccessible areas

1. Introduction, the museum as experience

Contemporary Museum has as purpose the historical telling of one or more educational field through the use of artifacts and messages exposed in a real or virtual way (Vitale, 2010). To enhance its capacity of attraction or re-attraction, nowadays the museum yearns to build up a delightful narrative by the integrated use of all the elements decision-making creating the museum identity: location, environment, communication, and, recently, inclusive services for supporting the visit (Vitale, 2013).

All those elements together allow the fruition of the museum exposition emotionally and with participation, perceiving the value of the whole as the prevailing summary of the single element, living the museum as an experience. For sure we know that today, the visit as an experience is one of the purposes that museums look for to grown in competitivity in respect of the decrease of economic resources intended for this industrial field. As we know to overcome this issue, it occurs to help the museum area of research with others expertise such as cognitive science, communications skills, technology integration and design strategies. Those competencies must support the museum curators in the planning of the Exposition activities establishing relations between purposes, strategies, and tools to enhance the museum aura as added value (Mottola, 1991).

With aims, we mean the directions in which the museum intends to stimulate the interest of visitors:

- Collecting: exposing vast collections rich in term of meaning.
- Give value: presenting original interpretations of the exhibits.
- Interact: creating opportunities for the public to interact, directly or indirectly, with the museum exposition.
- Diversify: creating itineraries visitors tailored, according to the time available or topics of interest.

Those aims has to be supported with strategies to be effective for the visitors:

- Storytelling: Creating an immersive exhibition and stimulating cognitive learning processes
- Building histories: disassembling and recombining the exposure dowels
- Exploring: driving the visitor to the joy of discovery
- Playing: introducing the ludic dimension of the gaming as access key for cultural information

The tools today available for operating with those strategies are of differents nature, and they could be used in an integrated way:

- Sensorial: based on the senses
- Analogs: a whole of solutions not only with a functional purpose but also used for communicating the environment, such as lights, sounds, movies, graphics
- Digitals: a very broad category which includes virtual reality, augmented reality, interactive media, and phygital applications.

Among the tools, in the last decade, they have made their appearance the robotic service systems. Those kind of instruments are going to deal with in more detail because object of our experimentation

figure 1 museum as experience

2. Context of the project

The project takes place from a case study settled in a museum hosted by a so-called villa of delights which is castle inserted in a UNESCO World Heritage site (Agosto et al., 2006). The main issues which influence the attraction of visitors to this museum site are on one side, the market competition with 16 others adjacent museum site consisting in the Piedmont Royal Residences cultural heritage. On the other hand, despite the richness of this heritage, it was estimated that around the 60% of the castle is not accessible for visitors, mainly because of the state of conservation, fragility or problems of logistic management. By the roboethics design strategy (Veruggio, 2006) since the beginning of the project all the differents stakeholders (Museum Guides, Museum Curators, Telecommunication Experts, Designers and Final Users) has been involved in the decision-making strategy with the scope to achieve a shared and innovative solution.
From this collaboration, a protocol model of study has been developed to satisfy all the needs of the museum attractivity:

- Accessibility to fragile areas
- Valuing the role of the museum guide, topic figure in the Museum - visitors relation
- Involvement of the visitors in activity with and high degree of interaction, aspect not yet present in the castle

3. Technological applications for Cultural Heritage

Nowadays, the technological application experience in the museum field is several and forecast several categories of devices (i.e. tablet, Vr glasses, interactive projections) (Grinter et al., 2002). The effectiveness of these requests derives from the synthesis of three factors: narrative, interaction, and context (Martignano, 2015). The narrative fulfills the function which regards the scientific knowledge (Dahlstrom, 2014). In fact, the narrative act on the user elaboration process, interpretative process and also on the comprehension and recall of facts. With a good narrative skill is possible to manage a pass event giving it a shape with the scope of make it easily describable and communicable. In the digital area of interest,

interaction is the discipline which study methods and strategies for design usable and reliable interactive system which facilitate human activities (Dix, 2009). The context represents the cognitive and informative reference in which an object is placed.
To those aspects are added others ones related to the interactivity (active or passive) (Liu et al., 2002) and the experience (sensorial or immersive).
Among the new digital categories integrated to the museum visit, for sure it is necessary to make a reflection about robotics. For the last two decades approximately the museum robotic experiments have succeeded getting contradictory results. The limits of those applications are of different nature; there are some issues related technology performance, or rather the used robot since now for the museum purpose present technological shortcomings that impact on performance and on the experience of visiting (often they have problems related to the handling) (Al-Wazzan et al., 2016). Alternatively, have interactive problems, that does not fully meet the demands of interaction regarding effectiveness and content and the expectations that the visitor come (Gu et al., 2016).

4. Methodology

With the intent of combine the need of making accessible the come areas of the museum with the technological integration, the research is structured following the development of a first robotics framework prototype. Which it has been used for doing feasibility, usability, and perceptive test and for verify the criticalities of the project.
The development of the robotics prototype has provided the involvement of telecommunication and robotics experts come from a research center which has support technological issues knowledge, and museum field experts (museum operator and curator) came from the cultural association in charge of the museum management.
The project follows the best practices of the roboethics design, meaning creating relations between all the actors involved in the project with the scope to reach a shared solution, and it is based on the interactive dialogue between all the stakeholders. In this sense, the relational role of the design helps the managing of those relations, and with the contemporary design methodology, it is possible to create value from them (Germak et al., 2008).
For approaching the project The design experience is based on the codesign methodologies. Codesign is a generative design process which provides the active and participatory involvement of the user in the design phase (Gajski et al., 1997). The role of the designer, in those process, is to facilitate the participation of the stakeholders, which are the experts of the ambit of the research. The designer facilitator role forecasts the support of the users to imagine and access to their experiences and expectation to actively and efficiently help the design process. To make sure that the co-design process would be effective it must operate trying to satisfy different types of experience (Sanders et al., 2008):

- Physics And tangible: doing things helps people to explore, record, remember and imagine
- Narrative: Telling stories and giving examples can help the user to project him needs respect the situation that is analyzing
- Gaming: Fun is a crucial aspect of the participation, it has a central role regarding the development of platforms based on sharing, building confidence, and helping people to express their needs. Gaming is also useful to keep high the attention level, this level decrease in the presence of boring activities

- Reflective: activities that support reflection and introspection help the user to express thoughts which are fixed in him daily lives in an accessible and agreeable way.

The research is conducted in two main phases, the first one is the commissioning of the robot, the second one, structured after the user test session, it consists in the direct involvement of the final user (museum visitors) in the interaction between the robot and visited environment.

4. Preliminary robot setup

The first phase provided the realization of the robotics prototype. The prototype classes from a redesign process from an industrial telepresence robot, and it is composed of the following four significant components:

- Four wheels movement system
- Camera video with live streaming capacity
- Laser scan able to avoid obstacle collision
- Cloud platform to manage the control software and the video connection (Hu et al., 2012)

In the first part of the project, the robot is driven by the museum guide, a figure which is not substituted in the museum visitors relation, rather the importance of the museum guide during the narrative of the exposition it is enriched with an innovative tool able to increase its capability. One of the elements which influence the most on the visit, when it is tour guided, is, in fact, the relation insured between visitors and museum guide and supply this figure with a higher degree of attractiveness will improve the experience of the visit. The tool through the museum guide interacts with the robot is a g.u.i. developed for tablets (Loppini et al., 2012), this interactive media is designed to facilitate the robot control tasks. Successively the images taken by the robot are transmitted on a shared screen where visitors can digitally visit the fragile areas of the museum where the robot is located. As it has been said before, one of the purposes of the contemporary museum is to attract visitors to the museum a to provide them with an experience that goes beyond the narrative of the exhibits, but that is more interactive and exciting. For this reason, although telepresence robot technology is usually used for the remote connections of large distances, in this phase of the research telepresence robot is used inside the museum, because very flexible and adaptable to several environments and also to define what are the facilitating factors of museum - visitor interaction (Sani et al., 2003).

The basic idea in this state of the research is to find a scalable model of the experience that can be repeated in several other museums but to achieve this goal it is necessary to limit the testing in a small setting environment.

The first phase of the project concluded with a series of test conducted with the scope of evaluating general appreciation of the experience, quality of the narrative and perceived impact of robots on the local context. The evaluation tests were managed through an anonymous questionnaire filled after the experience of the visit. The results of tests carried out on 55 people, the corresponding two sessions of guided tours of the castle, have yielded good results regarding enthusiasm for the proposed project, and on the general appreciation of the research. On the contrary, they also highlighted, especially for younger users (10-13 years), the desire to interact directly with the robot and not observe the visit only in a passive way

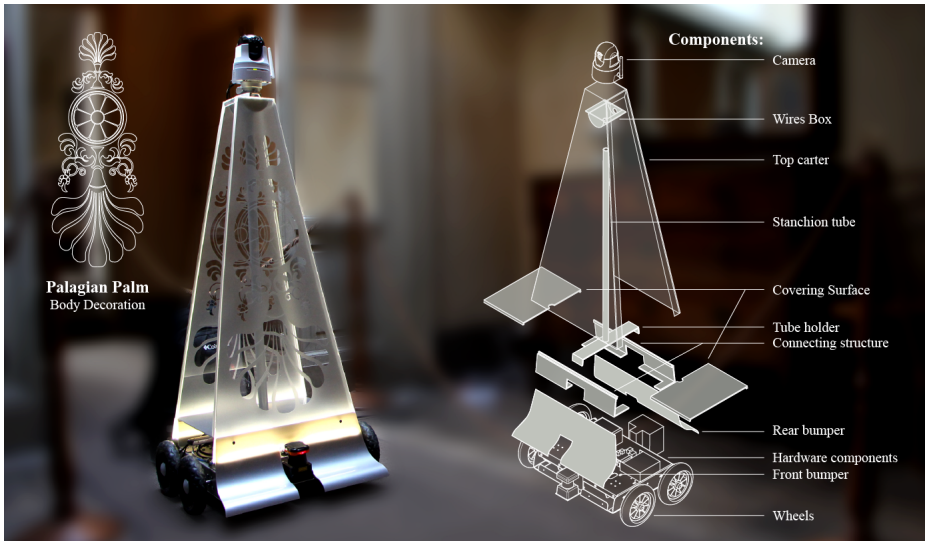

figure 2 robot prototype

5. Co-designing with school students

To respond to the expressed need of the younger user to have a more interactive experience a further step towards the direct interaction between visitors and robots thinking about the possibility to gamify the whole experience. Since the test showed that younger users had expressed a more interactive experience, from this point on, the project was supported by a high school class of students that helped the designers through co-design methodologies to give a design response to this directive.

Before to start the co-design phase, the following tasks has been conducted:

The museum guide has cataloged all objects in the areas dedicated to the experimentation, providing a report containing general information about them. The cataloging has provided the division of the objects in the following categories: objects of everyday life, the courtyard-style and personal care products, these classes of objects were then used to contextualize the cultural content of the game.

Designers and App developers have realized the structure of the gaming app. For the structure of the app means the basic pattern of the layout of the game structure. In this phase, we have not included the content of the game, but were taken care of graphical layout, ergonomics and button wireframe.

Co-design phase it has been structured in four days of workshops. Those four hours working meetings were made with the aim of implementing the multimedia content of the game and evaluate the confidence of interaction between user and robot. The days of workshops have been conducted both to the museum hosting the project, both in the high school media lab, a dedicated high school area for conduct a multimedia research containing several workstations with personal computers, internet connection, and other tools. The first day of the workshop it has been carried out on the museum and provided the simulation of the state of the art of the robotic service. It ha been a physical experience, in fact, the students have physically visited the castle together with the museum guide and, subsequently, they have performed the remote visit of the fragile areas through the use of the robot. At the end of the day was asked students who were the most interesting things they had seen through a questionnaire, these data were then crossed with the report made by the museum guide

for choosing what were the important objects on which working during the next stages. The three subsequent meetings were held instead in the high school media lab. This workshop phase provides the creation of three groups of work. The groups have been maintained until the end of the project, and to each one were assigned a category of objects to analyze (objects of daily life, the courtyard-style and personal care products). The assignment phase was randomized, but students preferences composed the groups, formed of an equal number of people. Dividing the application of the game into steps, each of them was analyzed with methodologies concerning the collaborative design asking to students advice how to improve it. The phases were treated with the students were the following:
Interactions with the game: in this phase, it has been taking care of the co-design of the interactions, these interactions are present in the game when the user has to find out what items has to look for, and when he receive the clues to find them. This phase was structured through brainstorming, during which students were provided with suggestions and with which they then developed a concept.
Creation of narrative content: after a brief lesson of introduction about research methodology, students investigate the content concerning to their class of objects, for this task groups were supervised by the museum guide who provided its cultural expertise. The cultural contents were subsequently used to structure both the questions in the treasure hunt and the multimedia video screened by the robot
Robot guide: students drove the robot through a process that simulates the one present in the museum.

6. A novel game application to explore the museum through the robot

Once finished the workshop, multimedia contents and desiderata emerged during the codesign phase have been integrated into the app. The structure of the game is based on the treasure hunt concept. Visitors after have visited the inaccessible areas of the museum with the robot, would have the ability to come back to that places driving themselves the robot and answer to a series of questions regarding several topics treated during the visit. Those topics could be different and for each one player could have a varied experience of the visit. The scope of the game is to answer three multiple-choice questions associated with three different objects present in the fragile areas of the museum. Before to answer to the questions the player, after receiving a clue, have to drive the robot towards the selected object. In this way through the semi-regarding drive of the robot, the visitor will have the capability of interact directly with the robot driving it, once the robot will be moved inside an area, this area could be visited with the 360° degree camera settled on the top of the robot. The camera furnishes a more immersive perspective of the area because camera movement of the robot corresponds to the action of the player which use the tablet with a haptic interface. The live streaming of the game is also duplicated on a big shared screen so everyone next to the players could give him suggest or interact with the game. The scope of the game is complete the treasure hunt in the faster way possible, and for making the experience more social involving the final score is compared to everyone played the game before.Therefore to complete the game, all the suggestion came out from the workshop were integrated on the game. The cultural contents were used to build the question list and have also been assembled in videos on the duration of 1 minute, used as a reward for the correct answer of the question. The rest of the suggestions were used to provide graphics and interactive application.

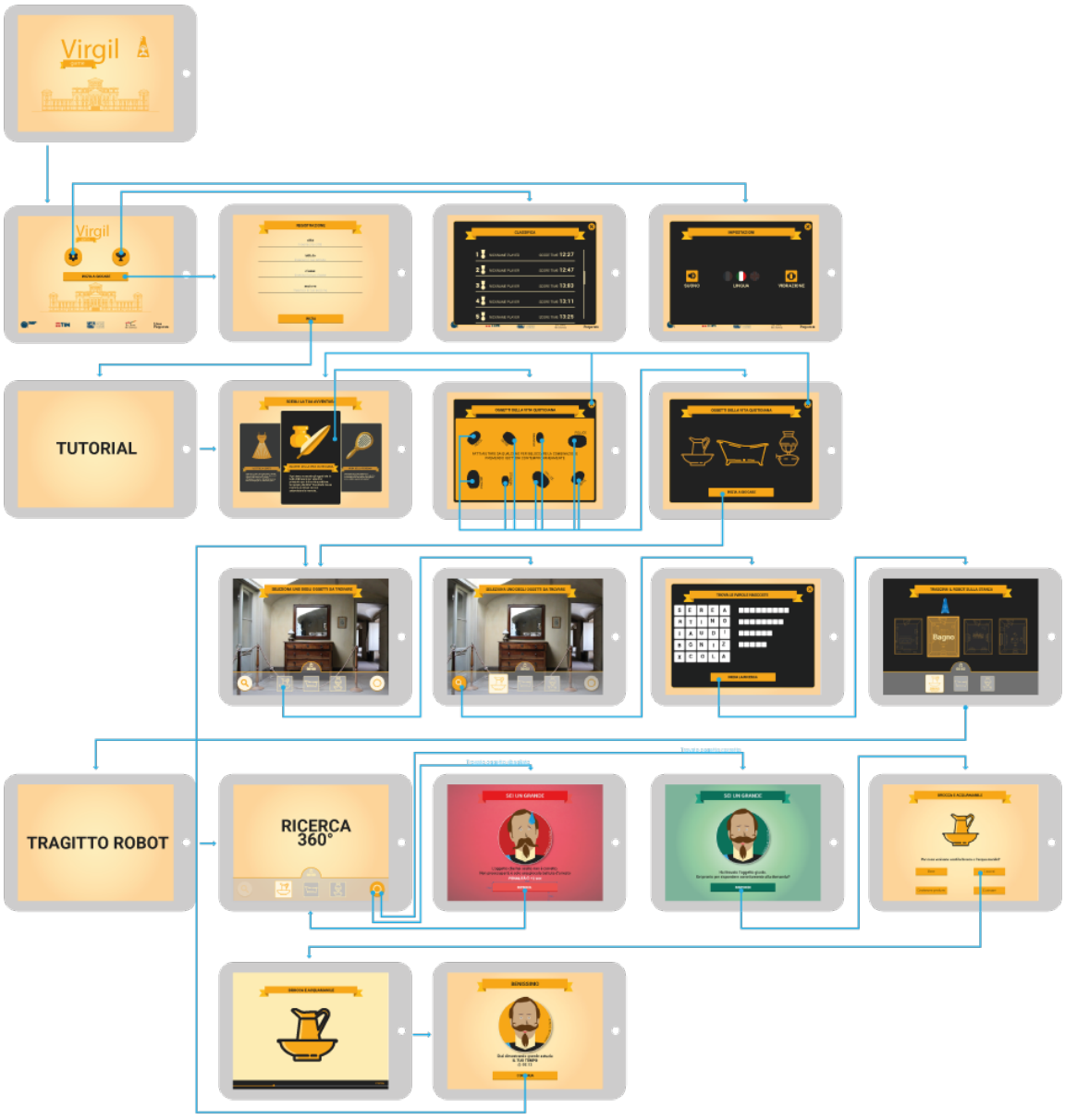

figure 3 worflowof the game

7. Results

To settle issues related to the low engagement by younger users in regard to the museum, a good project solution could be the insertion of the user in the design process. To understand better what were the factors appreciate the most by the students, a valuation questionnaire of the whole codesign experience has been compiled at the end of the workshop session. Table 1 highlight that user preferred the group activities and the activities concerning the creativity, while the activities research have a lower value.

Those results are useful because give a summary of the general degree of appreciation of the experience and, further, they provide feedbacks on the preferences of the students in respect of the activities proposed. This feedback will be used again in the future if there will be the need to organize another activity of this type.

Finally thanks to this activity it was possible to implement the robot interactivity into the museum's visit and also sensitize both final users and museum managers to a technology that has been seen not as a competitor but as a support to the visit. From the gaming point of view, the main result of the experiment was the realization of the tablet's application.

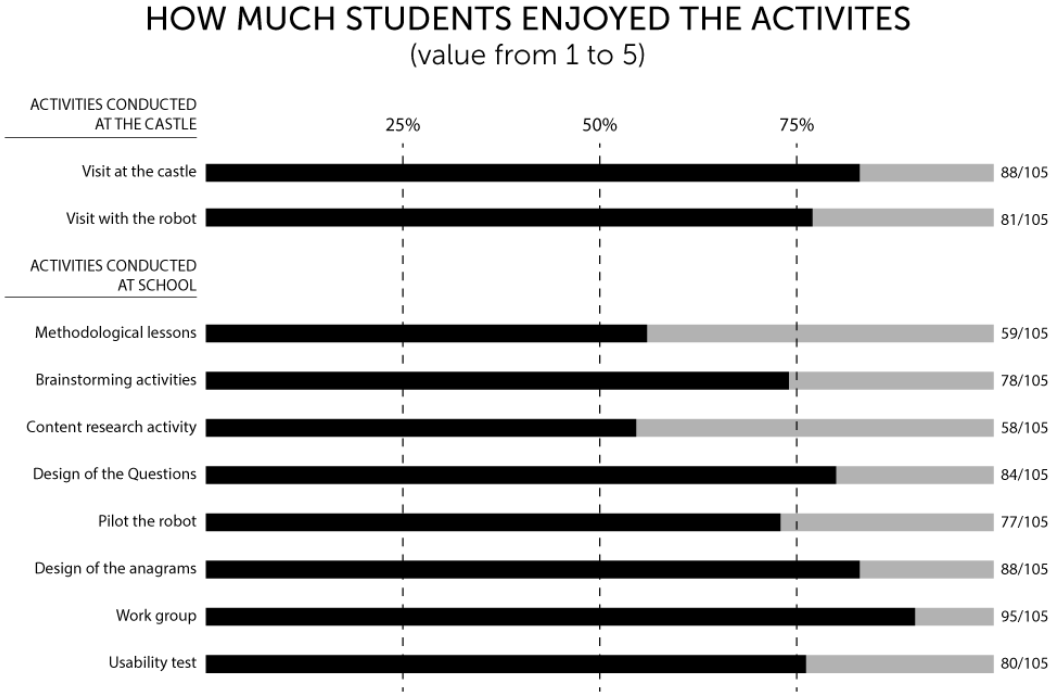

table 1 results of the questionarie

After the test the game, it has been implemented in the robot, which is configured for giving support to the museum visit. The prototype of the system is in advance work development, and it has been synchronized with the cloud platform to **enrol** others visitors on the experimentation. For which concern the design performance the robot reacts in a right way in term of acceptability, which is on of the most influent issue related to the human-robot interaction. The students appreciate the attempt to contextualize the physical appearance of the robot with the aesthetic museum language both for which concern the body shape and the game (characterization of Vittorio Emanuele). Concerning the robot handling, the project still has some improvable aspects, and further research will provide a focus on the robot driving

8. Conclusions

Through the project experience described in the paper, we would highlight how the use of robotics integrated with a direct involvement of the final user makes the project solution significantly more innovative and socially accepted (Nourbakhsh, 2013). Robotics devices which are slowly entering in the museum market field placing themselves always more in competition with other digital interactive forms (Brynjolfsson et al., 2012) . Especially for which concern the remote visiting museums use real or digital video which allows to the visitor to enter in a distant environment. If compared to this kind of solutions the project did not show advantages regarding visit performances, video quality is comparable to the standard of the market, and the solution rather presents advantages regarding flexibility and interaction. The intelligence of the robot which allows it to move and be driven in a semi-autonomously way by the visitor offers an experience more empathetic and less detached. In fact in interactive aspects robot takes full advantage of its potentiality. With the insertion of this kind of tool in the museum system, it would be possible experiment innovative categories of visiting, the job of the museum guide, which nowadays is living a severe crisis, could be evolved and obtain new skills, such as digital storytelling. Therefore, despite the user point of view new experience of the visit could be performed, today with the gaming, tomorrow through new interactivity.

References

Vitale, G. (2010). Il museo visibile. *Visual design, museo e comunicazione, Milano: Lupetti*.

Vitale, G. (2013). Design di sistema per le istituzioni culturali. Il museo empatico.

Mottola, A. (1991). Il libro dei musei. *Milan, Allemandi*.

Agosto, E., Ardissone, P., Rinaudo, F., & TODISCO, V. (2006, September). Open Source system for spatial and temporal data management, study case of the botanical census of the Royal Racconigi Park. In *International symposium on «Geodatabases for sustainable development»-ISPRS Commission IV Symposium, Goa-India* (pp. 27-30).

Veruggio, G. (2006, December). The EURON Roboethics Roadmap. In *Humanoids* (pp. 612-617).

Grinter, R. E., Aoki, P. M., Szymanski, M. H., Thornton, J. D., Woodruff, A., & Hurst, A. (2002, November). Revisiting the visit:: understanding how technology can shape the museum visit. In *Proceedings of the 2002 ACM conference on Computer supported cooperative work* (pp. 146-155). ACM.

Martignano, C. (2015). Il museo al tempo del digitale, seminario

Dahlstrom, M. F. (2014). Using narratives and storytelling to communicate science with nonexpert audiences. *Proceedings of the National Academy of Sciences*, *111*(Supplement 4), 13614-13620.

Dix, A. (2009). *Human-computer interaction* (pp. 1327-1331). Springer US.

Liu, Y., & Shrum, L. J. (2002). What is interactivity and is it always such a good thing? Implications of definition, person, and situation for the influence of interactivity on advertising effectiveness. *Journal of advertising*, *31*(4), 53-64.

Al-Wazzan, A., Al-Farhan, R., Al-Ali, F., & El-Abd, M. (2016, March). Tour-guide robot. In *2016 International Conference on Industrial Informatics and Computer Systems (CIICS)* (pp. 1-5). IEEE.

Gu, J. H., & Shin, D. H. (2016). The Importance of Robot Personality in a Museum Context. *The Journal of the Korea Contents Association*, *16*(3), 184-197.

Germak, C., Bistagnino, L., (2008). Uomo al centro del progetto Design per un nuovo umanesimo. Allemandi.

Gajski, D. D., Zhu, J., & Dömer, R. (1997). Essential issues in codesign. In *Hardware/Software Co-Design: Principles and Practice* (pp. 1-45). Springer US.

Sanders, E. B. N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design*, *4*(1), 5-18.

Hu, G., Tay, W. P., & Wen, Y. (2012). Cloud robotics: architecture, challenges and applications. *IEEE Network*, *26*(3), 21-28.
Loppini, F., & Bianchini, P. (2001). *U.S. Patent Application No. 09/846,572*.
Sani, M., & Trombini, A. (Eds.). (2003). *La qualità nella pratica educativa al museo*. Editrice Compositori.
Nourbakhsh, I. R. (2013). *Robot futures*. MIT Press.
Brynjolfsson, E., & McAfee, A. (2014). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. WW Norton & Company.

About the Authors:

GERMAK CLAUDIO Claudio Germak, full professor of Design at Politecnico di Torino, is an expert into the fields of user experience and interaction design for transportation system and service robotics. Member of the Board of SID - Italian Scientific Society of Design. Author of more than 130 pubblications.

GIULIANO LUCA I am a Ph.D. candidate in Design for Service Robotics, at Politecnico di Torino. My research, focused on human-robot interaction and cultural heritage, is supported by TIM. During my Ph.D. I was visiting scholar at HCDI institute (human center design institute), Brunel University, London (UK).

LUPETTI MARIA LUCE I am a PhD candidate in Design for Service Robotics, at Politecnico di Torino. My research, focused on human-robot interaction and play, is supported by TIM. During my PhD I was Publicity Chair for HRI Pioneers Workshop 2017 and visiting scholar at X-Studio, Academy of Art and Design of Tsinghua University (China).